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### ***Strategy***

Observations of NH<sub>2</sub>, [OI], CH, CO<sup>+</sup>, CO<sub>2</sub><sup>+</sup>, H<sub>2</sub>O<sup>+</sup>, and N<sub>2</sub><sup>+</sup> in optical spectra of comets represent ionization and dissociation products of virtually all of the volatile fraction of a comet nucleus, and can provide abundances of N<sub>2</sub>, NH<sub>3</sub>, H<sub>2</sub>O, CH<sub>4</sub>, CO<sub>2</sub> and CO. The primary objectives are to determine: 1) accurate production rates for the observed species, and 2) accurate relative abundances of condensates in a sample of comet nuclei. The ultimate goal is to constrain models of comet formation and chemical processing in the outer primordial solar nebula.

### ***Progress and Accomplishments***

Monte Carlo models of comet comae have been developed which include effects of multiple-step photodissociation, asymmetric gas flow, radiation pressure, and time-dependent outflow. Improved methods for extracting surface brightness profiles of NH<sub>2</sub> were developed and used to demonstrate that ammonia production rates can be determined from NH<sub>2</sub> spectra with relatively insignificant model dependence except in cases of highly active comets. A study of NH<sub>2</sub> in a diverse sample of comets indicated that the mean ammonia/water abundance ratio was ~0.1, with no significant variation among the comets. The apparent uniformity of the ammonia abundances among comets attests to a remarkable degree of chemical homogeneity over large scales (>1AU) in the comet forming region of the primordial solar nebula. A fluorescence model for the CN B-X band has been developed for determining the <sup>12</sup>C/<sup>13</sup>C ratio in a sample of comets.

### ***Projected Accomplishments***

Calculation of photoabsorption rates of a set of cosmically abundant molecules relevant to comets has been completed using cross sectional data complete to Jan 1991, and a relatively high resolution solar EUV spectrum. The solar rates together with a bibliography will be published. A list of unidentified molecular ion features in the optical region of comet spectra is being compiled. The program to determine the NH<sub>3</sub> abundances from NH<sub>2</sub> spectra in an enlarged sample of comets continues. Abundances and the structure of the comet ionosphere are being studied both spectroscopically and with narrow-band images. The N<sub>2</sub><sup>+</sup>/CO<sup>+</sup> ratio is being used to derive N<sub>2</sub>/CO abundance ratios in a sample of comets. Both spectroscopic and narrow-band images of comet Austin are presently being analyzed. The carbon isotope ratios are under study in several comets.

## **Publications**

1. Engel, L. 1990, **Unidentified Ions in Comets**, in *Workshop on Observations of Recent Comets (1990)*, eds. W. Huebner, P. Wehinger, J. Rahe and I. Konno, (San Antonio: Southwest Research Institute), p. 34.
2. Ferro, A. J. 1990, **A Multi-Generational Monte Carlo Model of a Comet Coma**, in *Workshop on Observations of Recent Comets (1990)*, eds. W. Huebner, P. Wehinger, J. Rahe and I. Konno, (San Antonio: Southwest Research Institute), p. 160.
3. Kleine, M. 1990, **Spectral Synthesis of CN in Comets**, in *Workshop on Observations of Recent Comets (1990)*, eds. W. Huebner, P. Wehinger, J. Rahe and I. Konno, (San Antonio: Southwest Research Institute), p. 116.
4. Wehinger, P. 1990, **Carbon Isotopes in Comets**, in *Workshop on Observations of Recent Comets (1990)*, eds. W. Huebner, P. Wehinger, J. Rahe and I. Konno, (San Antonio: Southwest Research Institute), p. 103.
5. Wyckoff, S. 1990, **Ammonia and Nitrogen Abundances in Comets**, in *Workshop on Observations of Recent Comets (1990)*, eds. W. Huebner, P. Wehinger, J. Rahe and I. Konno, (San Antonio: Southwest Research Institute), p. 28.
6. Wyckoff, S., Tegler, S. and Engel, L. 1991a, **Nitrogen Abundance in Comet Halley**, *Ap. J.*, **367**, 259.
7. Wyckoff, S., Tegler, S. and Engel, L. 1991b, **Ammonia Abundances in Four Comets**, *Ap. J.*, **368**, 427.
8. Wyckoff, S. 1991, **Comets: Clues to the Early History of the Solar System**, *Earth Science Reviews*, **30**, 125.